NUMERICAL SIMULATION OF SIZE DEPENDENT MICROMECHANICAL BEHAVIOR OF RUBBER-BLENDED POLYMER

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In rubber-blended polymers, the onset of cavitation in the particles relaxes the high triaxiality stress state and suppresses the onset of crazing in the polymer. As a result, large plastic deformation is substantially promoted compared with single-phase polymers. The effect of volume fraction and heterogeneity of the particles on the cavitation behavior under complex loading conditions has been investigated by the model in which a small void is introduced in the particle and the results indicate that the relations between the average normal stress and volume change of the particle are cast into a characteristic single line for all cases investigated[1]. On the other hand, the principal criteria[2] used to predict the onset of cavitation in rubber materials have related it to the volume strain energy stored in the particles and the surface energy on the inner surface of void. It has been shown that the effect of the surface energy on the cavitation behavior sharply increases with the reduction of the size of the particles. Consequently, the onset of cavitation is obstructed in the particles with a size smaller than a critical size.

To investigate the size dependence of the cavitation behavior in rubber-blended polymer, we consider the surface tension γ acting on the inner surface of preexisted void in the particle. For the computational convenience, the surface tension γ is replaced by the corresponding normal stress p_i acting on the same inner surface of the void. The magnitude of p_i is determined by the change of the curvature of corresponding point. Figure 1 indicates the results due to a primary study in which d_0 is the initial diameter of the particle and the average normal stress σ_n on the interface is normalized by the elastic modulus of the particle $E_{particle}$. We found that the decrease in the size of the particles causes the increase in the average normal stress on the interface and the relations between the average normal stress and volume change of the small particles are similar to those of hard particles. Furthermore, comparing the two set results of polymers containing the particles with different elastic modulus, it has been clarified that the size dependence of the cavitation behavior is enhanced for the polymers containing soft particles.

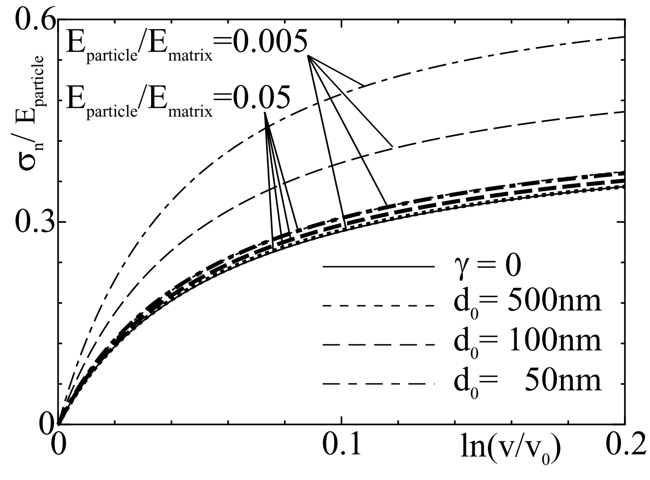

Figure 1: Average normal stress on the interface vs. logarithmic volumetric strain of particle.

References

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[2] C. Fond, "Cavitation Criterion for Rubber Materials: A Review of Void-Growth Models", *Journal of Polymer Science*, v. B37, p. 2081-2096, 2001.